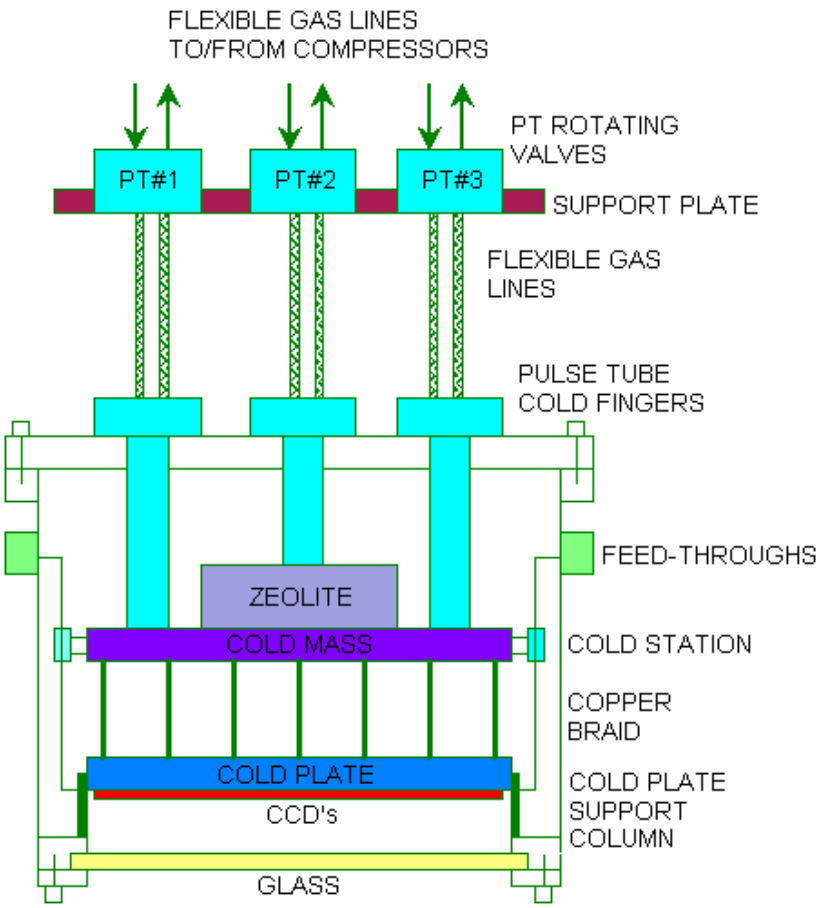
CTIO DARK ENERGY CAMERA
COOLING SYSTEMS

Del Allspach
1-22-04

- CAMERA USING PULSE TUBE COOLING
- CRYOMECH PT60 INFORMATION
- CRYO REFRIGERATOR EFFICIENCIES
- CAMERA USING LIQUID NITROGEN COOLING
- LIQUID NITROGEN RECONDENSING SYSTEM
- CRYOMECH LIQUID NITROGEN SYSTEM SPECS
- COOLING AND VACUUM SYSTEMS COST ESTIMATE



CTIO DARK ENERGY CAMERA

USING PULSE TUBE CRYO-REFRIGERATORS

NOT TO SCALE

D. Allspach, 1-21-04

CryoMech PT60 Information

D. Allspach, 1/9/04

- The vibration of the CryoMech PT60 cryorefrigerator at the cold finger has been measured at 6 microns in Z.

- Cold finger vibration in X and Y is roughly one-half this value.

- Vibration at the cold finger is a result of the compression and expansion of the process gas.

- Vibration at the flange has not been measured. However, it is considerably less than GM type refrigerators. PT refrigerators are used on MRI machines.

- The standard PT60 cryorefrigerator uses an AC motor. A DC motor may be special ordered for an additional cost of around $2000 per unit. This would reduce motor vibration. No vibration measurement is available.

- The motor may be remoted from the flange in order to reduce vibration at the flange. A reduction in cooling capacity will result. At one foot, a decrease of roughly 5% can be expected. Remoting the motor would imply that there is a location available on a massive part of the telescope at which the motors could be mounted or supported.

- The PT60 may be tilted up to 45 deg. Beyond this, a significant decrease in capacity will result. A 10% loss is estimated at 45 deg. The decrease is due to convective losses as the warm and cool gas mix. In its intended installed configuration, the cold end (cold finger) of the PT cooler is down.

- CryoMech testing has shown that when the PT60 is tilted from a vertical position to an angle of 45 deg while a heat load of 60 Watts is applied, the temperature increases by 25 K degrees (from 77 K to 102 K). The same type of test shows that when tilting the PT60 to 30 deg, the temperature increases by 16 K degrees (from 77 K to 93 K).

- Cost of the standard PT60 system is $12,400. This includes 10 ft. hoses.

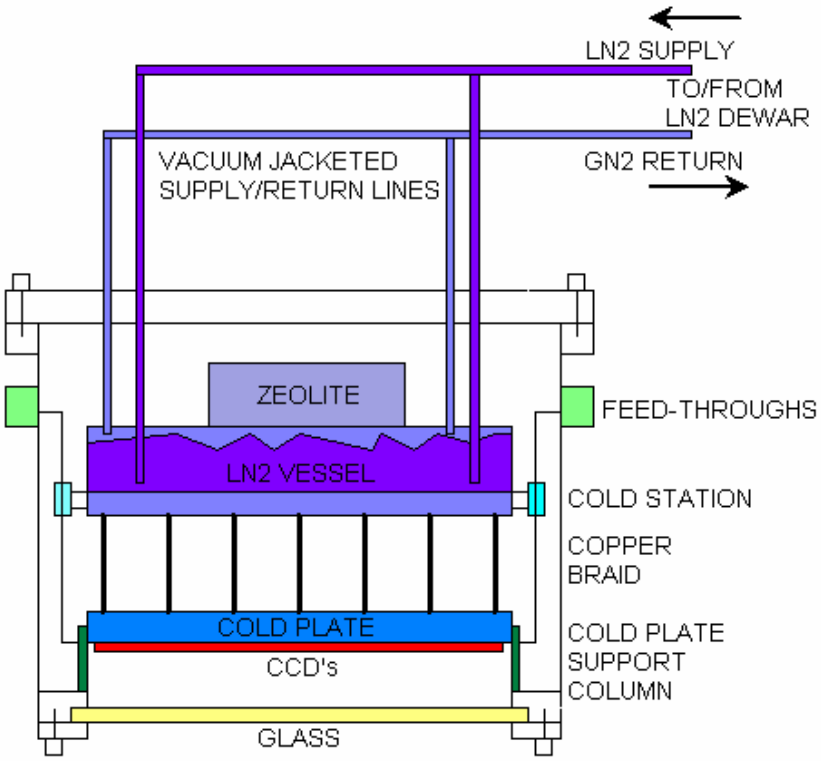
- The system has been designed for use in a laboratory setting. Use at cool ambient temperatures will likely cause process gas leaks. As a result, one operational issue to address is helium make-up.

- Meantime between maintenance expected > 20,000 hours based on design and a three month testing period. Results are based on continuous operation of the equipment.

Efficiency Chart of CryoRefrigerators

D. Allspach, 1/21/04

Type	**Model Reference**	**IN**	**OUT**	**RATIO**
PT	CryoMech PT60	3.0 kW	60 W @ 77K	50:1
JT	IGC Polycold CryoTiger	0.5 kW	3.5 W @ 77K	140:1
GM	CryoMech AL60	2.0 kW	60 W @ 80K	33:1
GM	CryoMech AL300	7.2 kW	300 W @ 77K	24:1



CTIO DARK ENERGY CAMERA

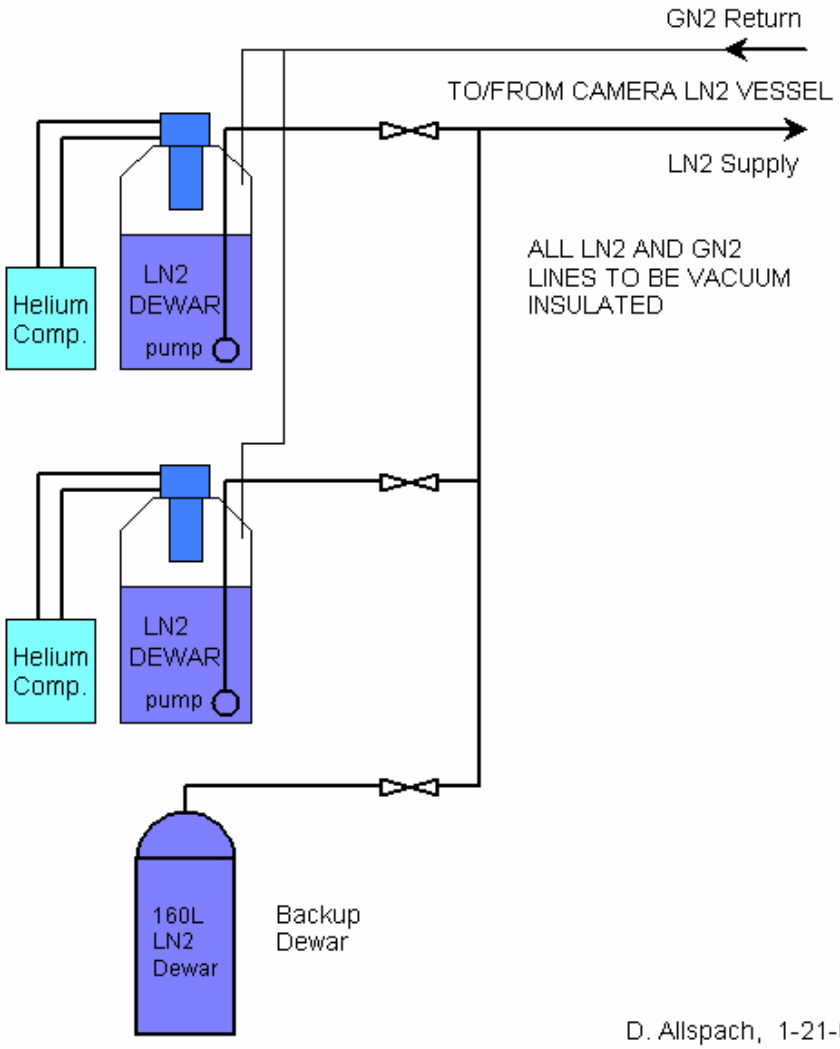
USING LIQUID NITROGEN COOLING

NOT TO SCALE

D. Allspach, 1-21-04

CTIO DARK ENERGY CAMERA

LIQUID NITROGEN RECONDENSING SYSTEM WITH BACK-UP



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CRYOMECH

CRYOMECH LNP-40 40 liters/day (1.66 l/hr)
Specifications

Storage Capacity (Dewar Size)……..160 liters
Standard Purity..... 98%
Power Requirements:
..... 5.5 kW @ 208/230 or 460 V, 3 phase, 60 Hz
…….200/220 or 380/400 V, 3 phase, 50 Hz
Dimensions:
Dewar assembly .....Diameter 24 in (61 cm)
.....Height 61 in (150 cm)
Helium compressor (L x W x H) .....
Water……...24 x 21x 26 in.(61 x 53.5 x 66 cm)
Air..... 24 x 21 x 54 in (61 x 53.5 x 137 cm)
Filters/Nitrogen Membrane Panel (L x W x H) .....
7 x 42 x 22 in... (18 x 107 x 59 cm)
Weight:
Dewar assembly ..... 250 lbs. (113 kg.)
Helium compressor ..... 425 lbs. (192 kg.)
Filters/Nitrogen Membrane Panel .. 45 lbs. (20 kg)
Ambient temperature range:
.....40°F to 100°F (4.5°C to 38°C)
Compressed air requirement:
..... 3.5 CFM at 80 PSIG (100 l/m at 7 bar A)
Air compressor supplied by Cryomech upon request.

CRYOMECH LNP-60 60 liters/day (2.5 l/hr)
Specifications

Storage Capacity (Dewar Size)……..210 liters
Standard Purity..... 98%
Power Requirements:
..... 7.5 kW @ 208/230 or 460 V, 3 phase, 60 Hz
…….200/220 or 380/400 V, 3 phase, 50 Hz
Dimensions:
Dewar assembly .....Diameter 30 in (76 cm)
..... Height 45 in (114)
Helium compressor (L W x H) .....
Water……...24 x 21x 26 in.(61 x 53.5 x 66 cm)
Air..... 24 x 21 x 54 in (61 x 53.5 x 137 cm)
Filters/Nitrogen Membrane Panel (L x W x H) .....
7 x 42 x 22 in... (18 x 107 x 59 cm)
Weight:
Dewar assembly ..... 250 lbs. (113 kg.)
Helium compressor ..... 425 lbs. (192 kg.)
Filters/Nitrogen Membrane Panel .. 45 lbs. (20 kg)
Ambient temperature range:
.....40°F to 90°F (4.5°C to 33°C)
Compressed air requirement:
.....6 CFM at 80 PSIG (180 l/m at 7 bar A)
Air compressor supplied by Cryomech upon request.

All specifications other than the capacity of the LNPs (liters/hour) and the input power are subject to change. Final specifications will be supplied at the time of the official quotation.

Cooling & Vacuum System Cost Estimate

D. Allspach / 1-21-04

PULSE TUBE REFRIGERATION SYSTEM Includes cost of three CryoMech PT60's modified for CTIO Camera use		$ 63K
LN2 COOLING SYSTEM Includes cost of two CryoMech LNP-60 Plants modified for CTIO Camera use. Cryo Pumps and Transfer Line included as well.		$ 144K
VALVES AND INSTRUMENTATION	PT: LN2:	$ 2 K $ 20K
MISCELLANEOUS Zeolite, Copper Braids, Connectors, etc.		$ 4 K
CONTROLS Includes Instrument Readout and Control; e.g. Auto LN2 batch fills.	PT: LN2:	$12K $25K
VACUUM PUMPING SYSTEM		$30K
ELECTRONICS COOLING SYSTEM		$ 6 K

TOTALS (Estimates to +/- 30%)

PULSE TUBE SYSTEM	$ 117K
LN2 COOLED SYSTEM	$ 223K